

A CONTRIBUTION TO THE KNOWLEDGE OF THE VARIATIONS OF THE TREE FROG *HYLA REGILLA*.

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It would be difficult to cite a department of natural history, animal or vegetable, that has not suffered more or less confusion from the extensive synonymy possessed by some of its west American representatives. This has come about by the too ready and free description as new of specimens brought in by the various Government exploring expeditions, and also by private individuals, often meager material collected at points whose precise location and geographical relation to each other were many times but vaguely understood. With, then, no intermediate forms at hand, and frequently with incomplete or no comparison with types already described from the same region, it is easy to see how the multitude of names has sprung up. In the case of alcoholic specimens, especially with batrachians, there was an additional source of danger from imperfect preservation, for if the alcohol were too strong the specimens would be hardened and contracted out of their normal proportions, while if it were too weak they would be macerated and relaxed, in either case rendering liable misidentification and consequent duplication of species.

The Pacific tree frog has not been neglected in the race for this sort of distinction, and indeed is well-nigh a leader, no fewer than seven names having been applied by different persons at various times to hylas from beyond the Rockies. It is with the idea of making an effort to clear up this ambiguity, which even the latest writers on the subject have left almost as cloudy as before, that this paper has been prepared, and it is purposed to show that all the tree frogs of the Pacific region, variant as they may seem at first glance, are really referable to but a single species. The collection at hand in the U. S. National Museum is the most extensive in existence, not only in the number of specimens, but also in the number and distribution of localities represented, comprising 512 specimens from 75 localities, and so a reasonable amount of confidence is placed in the conclusions reached from examining this mass of material.

The first mention of a Pacific hyla appears to be that by Baird and Girard, in October, 1852,<sup>1</sup> who, under "Descriptions of new species of reptiles, collected by the U. S. Exploring Expedition under the command of Capt. Charles Wilkes, U. S. N.," describe *Hyla regilla* as follows:

*Hyla regilla*: This is a species of medium size, the largest individual observed measuring one and a half inch from the nose to the posterior extremity of the body, the head itself occupying about half of this length. The hind legs are long and slender, the web extending only to half the length of the longest toe; fingers comparatively long. The general color is green above, turning to orange yellow along the sides of the head, abdomen, and legs. Two oblong, brownish black spots exist on the occiput, from which two vittæ (one pair) of the same black color extend along the dorsal region; a similar band passes from the tip of the nose, across the eye and tympanum, and along the abdomen, when it is interrupted, and forms a series of black and irregular small spots. In the immature state, green is the prevailing color, a few black spots being present along the whitish abdomen. Specimens of this species were collected on Sacramento River, in Oregon and on Puget Sound.

Two of these specimens still exist in a moderate state of preservation in the U. S. National Museum collection as Nos. 9182, from Puget Sound, Washington, and 15405, from Sacramento River, California.

Described in the same month as *Hyla regilla*, but a little later,<sup>2</sup> is *Hyla scapularis*, by Hallowell, from Oregon. After an anatomical description, in which attention is called to the granulations on the body, a point omitted by Baird and Girard, although their specimens possess rough skins, there is the following in regard to the skin:

Ground color above greenish olive, presenting numerous irregular bluish blotches upon the surface; several deeper colored blotches upon the sides; a bluish vitta, about two-thirds of a line in breadth, extends from the posterior part of the eye along the sides of the neck over the shoulder, a short distance beyond which it terminates; upper surface of extremities marked with bluish spots.

This specimen was not examined and may not now be in existence.

The next mention is by Baird and Girard in February, 1853,<sup>3</sup> where, in a list of reptiles collected in California by Dr. John L. Le Conte, *Hyla regilla* is included, and *Hyla scapularis* given as a synonym.

Following this, in July, 1854,<sup>4</sup> Hallowell describes *Hyla nebulosa* from two specimens collected at Tejon Pass, California, by Dr. A. L. Heermann. The granulations and other anatomical peculiarities are mentioned, and the color is described:

Uniform light gray upon the upper part of the body and sides; snout light ash; a considerable number of dark colored subcircular spots, about a line in diameter, scattered over the upper part of the body and upon the sides, in some specimens mingled with irregular blotches upon the back; extremities, ash color above, with grayish spots; abdomen greenish yellow; chin light yellow; under surface of extremities orange colored.

One of these specimens still exists in a very poor condition in the National Museum collection as No. 3230, which will be spoken of again.

<sup>1</sup> Proc. Phila. Acad. Nat. Sci., VI, p. 174.

<sup>2</sup> Idem, VI, p. 183.

<sup>3</sup> Idem, VI, p. 301.

<sup>4</sup> Idem, VII, p. 96.

Immediately following this description<sup>1</sup> is one of *Hyla scapularis* var. *hypochondriaca*. This is said to be—

Of a uniform pale olive color above, without spots, paler toward the sides; numerous small, elevated, smooth points upon the surface, resembling tubercles; upper surface of extremities pale olive; a narrow, dark colored vitta extending from the anterior margin of the eye to the snout, another much broader from the posterior margin of the eye to the shoulder; margin of upper jaw of same color as the vitta; posterior part of abdomen and under surface of extremities orange colored; chin and throat white; abdomen thickly granulated. It will be observed that it wants the squalus tooth-like mark upon the head and the markings upon the back which belong to *scapularis*.

These specimens also are in the Museum collection as No. 3235, Tejon Pass, California, Dr. A. L. Heermann, and a careful examination of them shows that two of the nine specimens do possess the squalus spot on the head, denied them in the original description, but it is very dim and indistinct, and there are also faint indications of dorsal stripes.

In 1866, owing to the preoccupation of the name *nebulosa* by a species of hyla described by Spix, Cope renamed Hallowell's specimens *Hyla cadaverina*.<sup>2</sup> As said above, one of the specimens is in the U. S. National Museum collection.

The same year<sup>3</sup> Cope described *Hyla curta*, collected at Cape St. Lucas, Lower California, by John Xantus. This is a stout form, with—size small, breadth of jaws entering total length two and two-thirds times. Males without gular vocal vesicle. Femur posteriorly unicolor, basal fold weak, a dark labial border and band from nostril to axilla, above ashy brown, with a dark interocular triangle and a broad dorso-lateral band on each side, often broken into elongate spots. Limbs punctulate and cross barred. \* \* \* The groin is sometimes mottled with black, and the sides often with brown or marbled, which may extend over the iliac region. Sometimes all the dark markings are marbled with paler. There is a band on the front of the humerus, and the hind limbs are frequently double banded.

These are in the Museum collection as No. 5293, nineteen specimens, and an examination leads to the belief that a small vocal sac does exist, as the throats of two or three of the males are slightly wrinkled, and that the apparent absence is partly due to the specimens being young, few of them being over an inch in length, and partly to their having been collected out of the breeding season.

In his "Batrachia of North America"<sup>4</sup> Cope gathered all the Pacific Hylas together as *Hyla regilla*, with the three varieties, *regilla* proper, *scapularis*, and *laticeps*. *Laticeps* he describes from eleven specimens from Cape St. Lucas (No. 5308, U.S.N.M.), collected by Xantus, but the description is very incomplete and confused from being mixed up with one of *curta*, which he seems uncertain whether to merge with the variety *regilla* or still keep separate. The three specimens of *scapularis*,

<sup>1</sup> Page 97.

<sup>2</sup> Journ. Phila. Acad. Nat. Sci., 2d ser., VI, p. 81.

<sup>3</sup> Proc. Phila. Acad. Nat. Sci., XVIII, p. 313.

<sup>4</sup> Bulletin No. 34, U. S. Nat. Mus., 1889, pp. 355-361.

said to be from San Francisco, I have been unable to trace. He distinguishes the three varieties by their proportions, *scapularis* being said to possess a long head and a long body, *regilla* a short head and a long body, and *laticeps* a short head and a short body, or, according to his key:

Head elongate; width equals length of body considerably over three times .....	<i>scapularis</i> .
Head short; width one-third of length .....	<i>regilla</i> .
Head short and broad; breadth contained in total length two and two-thirds times .....	<i>laticeps</i> .

It was inability to distinguish specimens by the employment of these characters so stated that led to the investigations to be detailed later.

The synonymy then stands:

*Hyla regilla* BAIRD and GIBBARD, Proc. Phila. Acad. Nat. Sci., 1852, VI, p. 171.

*Hyla scapularis* HALLOWELL, Proc. Phila. Acad. Nat. Sci., 1852, VI, p. 183.

*Hyla nebulosa* HALLOWELL, Proc. Phila. Acad. Nat. Sci., 1854, VII, p. 96.

*Hyla scapularis* var. *hypochondriaca* HALLOWELL, Proc. Phila. Acad. Nat. Sci., 1854, VII, p. 97.

*Hyla cadaverina* COPE, Jour. Phila. Acad. Nat. Sci., 1866, 2d ser., VI, p. 84.

*Hyla curta* COPE, Proc. Phila. Acad. Nat. Sci., 1866, XVIII, p. 313.

*Hyla regilla* var. *laticeps* COPE, Bulletin 34, U. S. Nat. Mus., 1889, p. 359.

According to Cope, *Hyla regilla* is most nearly related to *Hyla pickeringii*, *H. squirella*, and *H. eximia*. It has a decided resemblance in shape, and almost exact coincidence in habits, with *pickeringii*, its representative in the Northeast, but it is rather more robust than *squirella*, which takes its place in the South and Southeast.

Its distribution, as shown by the specimens in the U. S. National Museum collection, is mainly restricted to the Pacific watershed, from Vancouver Island and Chlewyuck Lake, Washington, to Cape St. Lucas, and from the coast to the east base of the Cascades and Sierra Nevada. Specimens from Walla Walla, Washington, and Chewaucan Valley, and Klamath Lake, Oregon, show that in this region its range is extended well into the desert area of the Great Basin, but in such case following streams which either rise in the Cascades or, like the Columbia, flow into the Pacific.

A most remarkable extension of its range occurs in the Death Valley region east of Mount Whitney, where *Hyla regilla* has been collected at isolated springs in desert ranges and valleys more than halfway across the Great Basin, reaching Vegas Valley, Nevada, the easternmost point recorded.<sup>1</sup> In this region it has been taken at Hot, Saratoga,

<sup>1</sup> Five specimens, No. 11534, long recorded as from "Eastern Colorado," are really from eastern California, the original label bearing "East Cala," instead of "East Colo.," as it was misread. One specimen, No. 11529, stated as being collected at Ringgold Barracks, Texas, is without definite locality, as that number is rightly occupied by a specimen of *Holbrookia maculata*. And No. 11481, one individual entered in the U. S. National Museum register as from Ogden, Utah, has probably been so done by mistake, as the species has not been found in the eastern part of the Great Basin elsewhere.

Resting, Pahrump, and Vegas springs, and in the Panamint and Charleston mountains. Of these, Hot Springs, the nearest point to the Sierra Nevada, is separated from that range by more than 40 miles, and like the other springs is situated in the midst of an extremely hot and arid desert. An almost equal distance intervenes between Johnson Canyon and Saratoga Springs, showing that in this semiisolated area the species seems to have spread from place to place by means not altogether satisfactorily explained at present. It may be that the distribution was brought about by the great inland lakes formerly existing in Panamint and Death valleys, and that the species, going up the streams flowing into them from various directions, or following the shrinking borders, has stranded where it is now found. At the present time the floods which occasionally swell the dry channels into temporary streams, thrusting out into the deserts to soon vanish, may assist in further increasing the range.

It has also been collected on Santa Cruz and Cerros islands, each nearly 20 miles distant from the mainland.

Moreover, it may be noticed that in altitude *Hyla regilla* ranges from sea level up to nearly 10,000 feet in the vicinity of Mount Whitney. Thus it occurs from the Lower Sonoran well up into the Boreal Zone, equal to the difference in the latitude between Florida and Labrador, and the extension of its range is thus second to that of no other hyla in North America. Within its range it is quite a common species, especially frequenting marshy land and the edges of springs, ponds, and other bodies of water.

*Hyla regilla* is a moderate-size species, the largest specimens in the collection measuring 47 mm., or not quite  $1\frac{7}{8}$  inches in length. The head is small to medium, rather more pointed than rounded in front, and shorter than broad, with the width at the tympana about one-third of the total length. In profile it is inclined to be flat, with the snout rounding. Eyes projecting only moderately, and tympanum about half the size of the orbit. A small fold of skin, beginning at the posterior angle of the eye, runs over the tympanum to above the arm. Another well-marked fold crosses the breast, just at the posterior edge of the arms, into which it is continued a short distance. The skin everywhere, except on the sides of the head, is covered with minute elevations, which on the abdomen, lower surface of thighs, and less on the throat, are crowded together as granulations. On the upper surface numerous larger papules or tubercles are intermingled with the smaller, becoming fewer on the head. Gular sac quite prominent in most males. The limbs are moderate. The fingers are free, except that a very slight web connects their bases. The disks vary from small to moderate. The length of the tibia is about half the total length. The webbing of the toes varies considerably, as do the disks. There is a small outer metatarsal tubercle, and a larger, marked inner one. A thin ala extends along the inner side of the tarsus.

The color of the under surface is almost always white or yellowish white, but that of the upper is extremely variant. In general it may be described as a lighter ground color, upon which are superimposed various markings, blotches, stripes, and spots, of a light or a dark brown. The ground color ranges in alcohol from a light grayish green to a dark, ashy olive, but the greatest variation in the coloring is especially in regard to the amount and distribution of the dark blotches. Still, though at first glance there seems to be no regular scheme in which the markings are applied, by looking more closely the different individuals can without apparent exception be arranged according to a system of five more or less distinct styles of coloration, which seem to follow each other in direct sequence, from few markings up to many.

There are no specimens absolutely without dark markings of some kind. Even the very lightest individuals of style I, as perhaps best shown in No. 3236, U.S.N.M., a large female from Shoalwater Bay, Washington, possess a dark vitta along each side of the head, a marking which is constant in the species in all of the five styles, and which indeed seems to serve as a foundation for the superstructure of added blotches. It consists of a rather wide brown line beginning at the snout, where it joins its fellow of the opposite side, and passing through the nostril, gradually widening until it reaches the eye. From the posterior angle of the eyelids it is continued back as a band nearly as broad as the orbit, inclosing the tympanum and passing over the arm to a point above the armpit. Here the side marking may stop, but as a rule it is carried farther back as a row of quadrate blotches and spots often reaching into the groin, and sometimes the band itself runs back the length of the humerus behind the axilla. There is a brown edging to the upper lip, which may be a little irregular, but is always present. This is the usual extent of the marking in style I (fig. 2), but very rarely light indistinct blotches may appear on the femora and tibiae of the largest individuals. In all the styles the space between the head stripe and the lip edging is considerably lighter than the ground color, in some being almost white below the tympana.

As remarked above, this combination of markings is also found in the other styles, with additional blotchings. In style II (fig. 3) begins a system of dorsal blotches, that is carried through those following, and enlarged upon. The first to appear is a triangular, or rudely Y or T shaped, blotch between the eyes, connecting the lids and running to about their centers and back to the tympana. In style II the stem of the Y may be lacking, and the branches not completely joined at the median line, or the stem and branches may all be present, though barely connected at the center. This is never the only dorsal marking, but stripes are always found with it. In style II there are two dorsal longitudinal stripes, beginning above the arms and separated by about one-third of the body width, running nearly or quite to the pelvic elevation. Often there are two or three cross bars on the femora, tibiae,

and tarsi, but not always, and rarely one or two small spots on the rump, posterior to the longitudinal stripes, as shown in a small male of No. 11498, U.S.N.M., from Walla Walla, Washington.

Style III (fig. 4) has the longitudinal stripes only about two-thirds as long as in style II, there are additional dorsal blotches, the bars on the hind legs are always present and pronounced, and the arms and forearms possess light bars. The dorsal spots, as admirably shown in specimens of No. 14727, U.S.N.M., from Fort Klamath, Oregon, are irregularly arranged in three rows, two continuing out the line of the stripes, and the third beginning about the middle of the body and running back along the median line, the last one being frequently located just above the anus. Two small spots are situated above the tympana midway between them and the cephalic blotch, and even with the end of the Y stem. The cephalic blotch is less often Y or T shaped, and rather a concave-sided triangle. A few minute spots may be exterior to the larger blotches. One individual referred to style III, from No. 11943, U.S.N.M., "Oregon," has the cephalic triangle reduced to a cross band, and the dorsal blotches broken up into over 30 irregular small spots with the ground color showing through their centers, producing a most curious, mottled appearance.

Styles IV (fig. 5) and V are natural sequences of style III. In style IV the anterior dorsal stripes are longer than in style III, resembling the condition in style II, and the posterior blotches are confluent into one or two more short stripes. There are also more spots on the top and sides of the rump and the dorso-lateral spots are larger. In this and V as in III, the bars and bands on the limbs are well marked.

Style V (fig. 6) passes easily from IV, the stripes lengthening, and the larger blotches becoming stripes, so that there are three longitudinal dorsal series of more or less broken stripes, one medial and two lateral, with numerous blotches and spots, especially about the rump. The lateral stripes begin above the tympana.

Of these, style I is distinct and sharply outlined by the absence of any dorsal markings whatever, and II is usually unmistakable, but III, IV, and V have a tendency to run into each other, and frequently can be separated only in a general way.

The different styles have been described, beginning with the lightest, as though those with more markings were the result of evolution in the adding of color. Yet, as a matter of fact, it is probable that the darkest style of coloration is closer to the primitive appearance, for not only do the majority of the other North American hylas possess the triangular blotch on the head, or two spots corresponding to it, with often dorsal markings also, but this condition is found as well in *Chorophilus*, *Acris*, and *Rana*, showing the wide extent of more color. It is a curious fact that the larger individuals are the darker, as indicated by figures drawn from the comparison of many specimens. There are exceptions, but that the averages from the bulk of individuals

show more than a tendency in this direction is well established by characteristics shown in the following tables:

*Characters of Hyla regilla from California west of the Sierra Nevada Range.*

Style of color.....	I.	II.	III.	IV.	V.
Number of specimens examined...	8	23	36	18	10
Average length in millimeters....	28.18	29.25	30.08	30.30	32.55

The numerical differences between these averages are small, but unmistakable, and considering the number of specimens taken into account, namely, 95, from several localities, they can be depended upon. Thirty-seven specimens from the Panamint Mountains also show the same relation between increase in size (age) and color.

*Characters of Hyla regilla from the Panamint Mountains.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens examined...	1	2	18	12	4
Average length in millimeters.....	32.50	34.25	35.05	37.04	38.125

This last shows the condition among individuals from an altitude of 6,000 to 7,000 feet, and the same holds true for 48 specimens from low desert valleys, Saratoga Springs and Panamint Valley, California, and Ash Meadows and Oasis and Vegas valleys, Nevada.

*Characters of Hyla regilla from desert valleys.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens examined...	0	13	17	14	4
Average length in millimeters.....		24.46	25.70	28.28	32.125

The law is good for 51 individuals from Oregon and Washington, with the slight exception that the average length in style II is greater than that in style III, an irregularity of no moment, considering that only 7 specimens of each were measured and in view of the figures already given.

*Characters of Hyla regilla from Oregon and Washington.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens examined...	23	7	7	5	9
Average length in millimeters.....	25.74	31.21	28.42	33.70	35.33



In the case of 31 specimens from Lower California, they are all of so nearly the same size as to show no decided tendency, one way or another,<sup>1</sup> as follows:

*Characters of Hyla regilla from Lower California.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens examined...	3	2	11	11	4
Average length in millimeters.....	30.66	27.25	30.66	30.66	30.50

In regard to whether there is a difference in color between the sexes, the males appear to average a little heavier marking than do the females, as indicated by the following data:

*Characters of males and females of Hyla regilla.*

Style of color.....	I.	II.	III.	IV.	V.
Number of males .....	3	10	37	43	15
Number of females.....	22	19	24	12	8

Of the 108 males examined, 50 belong to the first three styles, and 58 to the latter two, thus throwing the average between styles III and IV, and nearer to IV. Forty-one of the 85 females come under the first two styles, so that they average between styles II and III, with a slight margin in favor of style III. These results are influenced, however, by the fact that the majority of the specimens from the south, which are darker, are also males, while of the lighter specimens of the north more females seem to have been collected. It is possible that if the sexes were equally represented from each locality the average coloration would be practically the same.

In this connection comes up the point of distribution of color north and south, hinted at above. The figures already given in showing the relation between size and color indicate that northerly the first styles of color are more numerously represented than in the south, and vice versa. A color observation of 323 individuals bears out this indication and proves it to be a law. The following tables show the distribution of color if the range of the species be divided into three sections—north, middle, and south.

<sup>1</sup>The fact, which then seems to be firmly established, that the younger individuals are the lighter, and that they become gradually darker as they increase in size, really would seem to indicate that the ancestral color was light and with few markings, were it not for the overwhelming testimony offered by allied forms that the primitive appearance was darker, for it is hardly likely that they have all evolved in the same color direction. At present the solution of the seeming contradiction does not present itself.

*Characters of Hyla regilla from Oregon and Washington.*

Style and color .....	I.	II.	III.	IV.	V.
Number of specimens .....	23	7	7	5	9

The average of these 51 lies between styles I and II.

*Characters of Hyla regilla from California north of Santa Barbara.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens .....	26	27	38	31	14

In this case the average is seen to fall in style III, a decided addition of markings over the specimens from farther north, and the adding of color goes on in the southern section, where the average is between styles III and IV, as seen:

*Characters of Hyla regilla from California south of Santa Barbara, including Lower California.*

Style of color .....	I.	II.	III.	IV.	V.
Number of specimens .....	12	9	50	55	10

Thus the adding of pigment is shown to increase gradually from the north to the south, and though these figures were taken from the markings, they will probably apply nearly as well to the ground color, which darkens with added blotches. In Washington, particularly, the ground color is very light, in striking contrast to specimens from Santa Ysabel, San Diego County, California, in which it is so dark an ashy green as to decidedly obscure the markings. It is difficult to account for this darkening in southern latitudes. As a rule dark tints are associated with moisture, but it does not seem to hold in this case, for the forests of Washington and Oregon certainly have a damper atmosphere than do the sandy plains and valleys of southern California and Nevada, and yet in the northern states nearly half of the individuals come under style I, while the desert specimens average in style III, or nearly IV, and the specimens of style I are very few. So, possibly, the deepening of the pigment may be attributable to the southern sun. Yet it will be seen that the several styles occur throughout the range, and all would probably be found represented in every locality, if 100 or more specimens were examined.

In spite of the great variance in color, then, the different styles are so closely connected, and to a great extent actually confluent, that the unity as a species in this respect is very evident. Since Cope, however, separates three varieties by means of the relative proportions, that is another point to be looked into. In order to ascertain their exact value

very careful measurements were made of 304 specimens throughout the entire range, the results of which are given below. The method pursued was as follows: With a pair of sharp pointed dividers the length from the tip of the snout to the end of the pelvis, the breadth of the head at the posterior edges of the tympana, and the length of the tibiæ, were determined in millimeters and half millimeters. Where the two tibiæ were found to be of different lengths, and quite often the left one was a very little shorter, the average was taken as nearly as possible. Then the proportion of the head to the body was found, and of the tibiæ to the body. To establish a constant standard, the length of the body in all cases was fixed at 100, and the breadth of the head computed in percentage of this. In most cases this proportion varied from 32 to 36 per cent. In like fashion in the second proportion, the length of the body being still fixed at 100, the length of the tibiæ was calculated to suit it, the figures usually being found to range from 48 to 50 per cent. In order to insure as complete accuracy as possible, in the great majority of cases each measurement was taken twice, and the result obtained by the proportion was calculated to two decimal places, thus indicating the more delicately any variation, and proving of advantage when the averages were struck. The uniformity with which, approximately, the same figures reappeared was a matter of some little surprise at first, in the light of the proportions claimed by Cope in distinguishing his three varieties, but the persistence removed all doubts as to its correctness. As was to be expected, some few specimens gave extreme figures, which taken alone might indicate almost a subspecific difference, but the gaps are so completely filled in, usually by specimens from the same locality even, that the discrepancies are unmistakably due to individual variation and exaggeration, and have no real significance. Since the proportion of the head and body is the one used by Cope in separating his varieties, especial notice has been paid to that, but it is found to differ no more than does that of the body and tibia, which is very little.

The narrowest heads observed give the proportions of 30.96 per cent in the total length, or entering it not quite three and a quarter times. But this is found in only 3 specimens, 2 from Puget Sound and 1 from Fort Tejon, California, and as the specimens are quite small, only 21 mm. in length, and since the head appears to be normally slightly narrower in younger individuals, it is probable that this accounts for the proportion. At all events, it seems clear that it is a case of individual variation, and of no value as a varietal distinction.

The broadest head belongs to a specimen from the Panamint Mountains, Johnson Canyon, with the proportion of 39.48 per cent, but another specimen from that locality has a head 34.67 per cent, and the average of 34 specimens is 36.83 per cent. This seems an approach to the variety *laticeps*, but *laticeps* was described from Cape St. Lucas specimens, and besides really does not exist, to judge from the proportions of the type specimens. To them Cope ascribes a head breadth of

two and two-thirds times in the total length, or, then, a proportion of 37.50 per cent. Careful and repeated measurements of the types of *laticeps* show that the widest head from among 9 specimens is only 34.78 per cent, while there is 1 as narrow as 31.44 per cent, and the average is 33.08 per cent. The types of *curta*, from practically the same locality, have extremes of 35.19 and 32.11 per cent, and an average of 33.67 per cent.

The accompanying table will serve to show more plainly the proportions of specimens from some of the different localities:

*Proportions of Hyla regilla.*

Locality.	Number of specimens.	Average length.	Ratio of head to body.			Ratio of tibia to body.		
			Broad-est.	Narrow-est.	Average.	Long-est.	Short-est.	Average.
Vancouver Island, British Columbia.....	1	<i>mm.</i> 40.00			35.81			47.50
Fort Vancouver, Washington.....	6	24.60	34.21	31.88	33.11	50.00	47.82	49.53
Puget Sound, Washington.....	16	26.28	34.70	30.96	32.38	52.50	47.87	49.78
Shoalwater Bay, Washington.....	1	47.00			31.92			48.93
Walla Walla, Washington.....	3	30.50	33.93	32.79	33.34	49.80	46.42	47.74
Fort Umpqua, Oregon.....	3	35.00	34.18	31.17	32.23	49.35	48.10	48.53
Fort Klamath, Oregon.....	12	35.87	34.09	31.83	33.07	52.27	45.16	48.51
"Oregon".....	10	25.45	35.42	31.92	33.58	52.00	48.08	50.12
Sonoma County, California.....	20	31.50	34.48	31.49	33.17	52.50	46.46	48.60
Lake Tahoe, California.....	23	22.89	36.17	31.25	33.73	52.77	47.91	50.14
Monte rey, California.....	10	33.05	36.76	33.33	34.66	52.33	48.57	50.39
Santa Barbara, California.....	20	30.04	36.06	32.56	34.15	52.27	47.76	49.74
Santa Cruz Island, California.....	20	35.45	38.24	33.68	36.46	51.51	47.43	49.89
Old Fort Tejon, California.....	17	33.60	36.42	31.82	33.79	52.50	48.57	50.58
Panamint Mountains, California.....	34	36.32	39.48	34.67	36.83	52.11	46.15	49.44
Hot Springs and Saratoga Springs, California.....	10	28.65	37.40	32.49	34.78	50.00	46.51	47.96
Ash Meadows, Nevada.....	14	27.00	35.18	31.74	32.90	49.12	45.83	47.83
Oasis Valley, Nevada.....	10	27.45	37.28	34.54	35.61	46.40	44.23	45.00
Pahrump Valley, Nevada.....	5	26.90	35.48	32.44	34.04	50.00	45.60	47.83
Between Pahrump and Vegas valleys, Nevada.....	2	38.00	36.50	35.90	36.20	47.30	46.15	46.72
Vegas Valley, Nevada.....	11	25.80	38.46	35.01	36.87	48.71	44.00	46.23
Ogden, Utah.....	1	40.00			32.56			51.25
San Diego, California.....	11	28.40	34.00	31.58	32.79	52.33	49.09	50.09
Santa Ysabel, California.....	14	30.64	32.27	32.14	33.52	50.91	47.00	48.66
Average from San Diego County, California.....	25	29.68			33.38			49.28
Cape St. Lucas, <i>curta</i> .....	15	26.30	35.19	32.00	33.67	50.94	48.00	49.87
Cape St. Lucas, <i>laticeps</i> .....	9	33.88	34.78	31.44	33.08	51.61	45.07	49.24
Average of last two.....	24	29.14			33.44			49.66

From the above it will be seen how close together the averages run, especially in regard to head proportions, though there is not much variation in those of the tibiae. Still, in the desert localities, the legs become a very little shorter and at the same time the head a trifle broader, the animal assuming rather more of a squat form, in accordance with its changed surroundings. As a rule, the gradations show beautifully—as, for instance, in passing from Pahrump to Vegas valleys. It appears that the northern specimens have rather narrower heads than those farther south, and particularly when compared with the desert forms, but the difference is so slight and so inconstant as to make it impracticable as a basis for nomenclatural distinction.

Of the North American hylas, *regilla* is one of the most limited in the extent of the digital disks and webbing of the feet. Although

there is considerable variation in this, as in all else, still the diminution is very marked as a rule, in some cases being not much more than is found in some species of *Chorophilus*. This has been naturally brought about to some degree by the scarcity of water in a part of the range and by the diminished vegetation which accompanies and is implied by the lessened moisture. Where trees and shrubs exist, as in the higher altitudes of middle and southern California and Nevada, as distinguished from the lower valleys and deserts, and in northern California, Oregon, and Washington, *regilla* tends to become more arboreal, but it is generally terrestrial in its habits, resembling, as said before, *Hyla pickeringii*, in being chiefly found about ponds, springs, and like moist localities. This may account for the size of the digital disks being reduced to a greater degree than is the webbing between the toes, for though the arboreal life might be only rarely possible, the opportunity for swimming would more frequently present itself.

As would be expected, then, the greatest reduction is usually found in the desert region, the webbing increasing toward the north and with rising altitudes. In spite of the indication, however, that with higher altitudes go more webs, Nos. 20190–203, from Santa Ysabel, at an altitude of some 1,500 feet, in the mountains of San Diego County, have the smallest webs and disks of all examined. The specimens were fresh, collected considerably less than a year before they were examined, and were in perfect preservation, so that the reduction is natural, and not due to shrinkage in the alcohol. The web (fig. 8), starting from the base of the first phalanx of the fifth toe, swings back, but is attached to the fourth toe at the joint between the second and third phalanges. Sweeping back from a corresponding point on the opposite side of the toe, it is brought forward again to the joint between the first and second phalanges of the third toe, and starting from a little back of the end of the second phalanx, it is attached midway the first phalanx of the second toe. From near the joint of the first phalanx it then goes to a like point on the first toe. This small amount of webbing is also found in specimens from Santa Barbara and Sonoma County, and the disks are correspondingly lessened.

But in specimens from Johnson and Surprise canyons, Panamint Mountains (altitude 6,000 feet), of even more arid character than Santa Ysabel, the webbing reaches its maximum (fig. 9), connecting the bases of the disks on all the toes, though the last phalanges of all except the fifth are merely widely fringed. In no other specimens do so much web and so large disks occur.

The usual webbing, however, of middle and southern California and Nevada, though like the specimens from Ysabel in other respects, differs in that the webbing runs up both sides of the fourth toe to the middle of the second phalanx. This degree is also found in Cape St. Lucas specimens, and, only slightly increased, in those from Lake Tahoe, though these show the change toward the northern type.

The invariable condition north of California, and which occurs also in

the Sierra Nevada and Panamint Mountains, is one of much more decided webbing and larger disks (fig. 10). The web seems to arise from the middle of the first phalanx of the fifth toe, though really fringing it to the disk, and after the sweep back runs to the joint between the first and second phalanges of the fourth toe, though keeping rather close to the second phalanx. From here, again, it fringes the first phalanx of the third toe to the disk, and in like manner the others. The existent type specimens of *regilla* belong in this category.

From the various data given there seems to be but one conclusion to draw—which is, that the various species of Pacific hylas described within the last forty-five years appear to have been established on insufficient characters, and intergrade to such a degree as not to be specifically or even subspecifically separable. Although northern specimens may seem to be lighter and to have narrower heads, and desert specimens to be darker and shorter limbed, and in spite of all the numerous differences in color, in proportion, and in webbing, still all intergrade and are finally referable to one species, *Hyla regilla* of Baird and Girard.

In conclusion, I wish to express my deep obligation to Dr. Leonhard Stejneger, curator of the reptile department of the U. S. National Museum, for the opportunities he has afforded me for studying these forms, and various kindnesses and aid in the preparation of this paper.

I append a list of the specimens of *Hyla regilla* in the U. S. National Museum.

*List of specimens of Hyla regilla in U. S. National Museum.*

Mus. No.	Number of specimens.	Locality.	Collector.
3227	32	Sonoma County, California.....	E. Samuels.
3229	2	Yuba, California.....	Dr. J. S. Newberry.
3230	1	Tejon Pass, California.....	Dr. A. L. Heerman. Type <i>nebulosa</i> .
3232	3	Fort Vancouver, Washington.....	Dr. J. G. Cooper. Type <i>cadaverina</i> .
3235	9	Tejon Pass, California.....	Dr. A. L. Heerman. Type <i>hypochondriaca</i> .
3236	1	Shoalwater Bay, Washington.....	Dr. J. G. Cooper.
3238	4	Fort Reading, California.....	Dr. Hammond.
3245	3	Monterey, California.....	Dr. G. Suckley.
3240	3	Fort Vancouver, Washington.....	Dr. J. G. Cooper.
3252	5	Puget Sound, Washington.....	Dr. G. Suckley.
3253	1	Asforia, Oregon.....	Lieut. W. P. Trowbridge.
4552	3	Fort Umpqua, Oregon.....	Dr. E. Vollum.
4895	9	Fort Tejon, California.....	J. Xantus.
5293	19	Cape St. Lucas, California.....	J. Xantus. Type <i>curta</i> .
5308	11	Cape St. Lucas, California.....	J. Xantus. Type <i>laticeps</i> .
5932	3	Fort Crook, California.....	John Fiedler.
5977	7	Puget Sound, Washington.....	Dr. C. B. Kennerly.
6629	4	Santa Barbara, California.....	Dr. Webb.
8572	1	Cerro Island, Lower California.....	Dr. J. H. Streets.
8682	22	Lake Tahoe, California.....	H. W. Henshaw.
8688	37	Santa Barbara, California.....	H. W. Henshaw.
8697	1	Fort Tejon, California.....	H. W. Henshaw.
8701	7	Santa Barbara, California.....	H. W. Henshaw.
8702	1	Mount Whitney, California.....	H. W. Henshaw.
8703	4	Fort Tejon, California.....	H. W. Henshaw.
8704	1	Los Angeles, California.....	William Somers.
9181	4	Puget Sound, Washington.....	
9182	1	Puget Sound, Washington.....	C. P. Expl. Exped. Type <i>regilla</i> .
9424	1	Chilowynck Lake, Washington.....	Dr. C. B. Kennerly.
9486	1	Monterey, California.....	W. H. Dall.
9491	1	Cottonwood Canyon, California.....	
9496	1	Monterey, California.....	W. H. Dall.

List of specimens of *Hyla regilla* in U. S. National Museum—Continued.

Mus. No.	Number of specimens.	Locality.	Collector.
9499	5	Lake Tahoe, California.....	H. W. Henshaw.
9500	2	Southern California.....	H. W. Henshaw.
11123	12	(?)	(?)
11481	1	Ogden, Utah.....	Expl. W. 100th Meridian.
11498	3	Walla Walla, Washington.....	Capt. Charles Bendire.
11522	4	Chewaukan Valley, Oregon.....	H. W. Henshaw.
11529	1	(?)	(?)
11534	5	East California.....	H. W. Henshaw.
11574	11	San Diego, California.....	Dr. John Le Conte.
11920	1	Monterey, California.....	Dr. D. S. Jordan.
11940	3	Fort Bidwell, California.....	H. W. Henshaw.
11943	10	"Oregon".....	H. W. Henshaw.
11947	2	Plumas County, California.....	G. Thompson.
11969	2	Cerro Island, Lower California.....	L. Belding.
12659	2	La Paz, Lower California.....	L. Belding.
13457-9	3	La Paz, Lower California.....	L. Belding.
13609	1	Lower California.....	C. R. Orcutt.
13610	2	San Diego, California.....	C. R. Orcutt.
13768	3	Des Chutes River, Oregon.....	Capt. Charles Bendire.
13796	1	Baird, California.....	C. H. Townsend.
13894	1	San Diego, California.....	C. R. Orcutt.
13953-4	3	Berkeley, California.....	R. E. C. Stearns.
13961	1	Sierra Nevada Mountains, California.....	R. E. C. Stearns.
14077	1	Baird, California.....	L. W. Green.
14727	9	Fort Klamath, Oregon.....	Dr. J. C. Merrill.
15409	1	Sacramento River, California.....	Expl. Exped. Type <i>regilla</i> .
15440	1	Fort Klamath, Oregon.....	Dr. J. C. Merrill.
15918-37	20	Santa Cruz Island, California.....	C. H. Townsend.
16287-8	2	San Diego, California.....	C. R. Orcutt.
16289	1	(?)	(?)
16524-6	3	San Diego County, California.....	C. R. Orcutt.
17408	1	Los Angeles, California.....	M. M. Green.
18790-823	34	Johnson Canyon, Panamint Mountains.....	Death Valley Expedition.
18824-7	4	Surprise Canyon, Panamint Mountains.....	Death Valley Expedition.
18828-9	2	Panamint, Panamint Mountains.....	Death Valley Expedition.
18830	1	Whitney Creek, California.....	Death Valley Expedition.
18831-6	6	Whitney Meadows, California.....	Death Valley Expedition.
18837	1	Mount Whitney, California.....	Death Valley Expedition.
18838-9	2	Panamint Mountains, California.....	Death Valley Expedition.
18840-5	6	Panamint Valley, California.....	Death Valley Expedition.
18846-52	7	Rosing Spring, California.....	Death Valley Expedition.
18853-5	3	Saratoga Springs, California.....	Death Valley Expedition.
18856	1	Hot Springs, California.....	Death Valley Expedition.
18857-8	2	Kern River, California.....	Death Valley Expedition.
18859	1	Walkers Basin, California.....	Death Valley Expedition.
18860	1	Antelope Valley, California.....	Death Valley Expedition.
18861-4	4	Old Fort Tejon, California.....	Death Valley Expedition.
18865	1	South Fork Merced River, California.....	Death Valley Expedition.
18866	1	Horse Corral Meadows, California.....	Death Valley Expedition.
18867	1	Kings River, California.....	Death Valley Expedition.
18868-70	3	Cottonwood Meadow, California.....	Death Valley Expedition.
18871-4	4	Monterey, California.....	Death Valley Expedition.
18875-9	5	Charleston Mountains, Nevada.....	Death Valley Expedition.
18880-4	5	Pahrump Valley, Nevada.....	Death Valley Expedition.
18885-6	2	Between Pahrump and Vegas valleys, Nevada.....	Death Valley Expedition.
18887-8	2	Corn Creek, Lincoln County, Nevada.....	Death Valley Expedition.
18889-90	11	Vegas Valley, Nevada.....	Death Valley Expedition.
18900-1	2	Vegas Valley Cottonwood Spring, Nevada.....	Death Valley Expedition.
18902-12	11	Oasis Valley, Nevada.....	Death Valley Expedition.
18913-26	14	Ash Meadows, Nevada.....	Death Valley Expedition.
19277	1	San Quentin, Lower California.....	G. P. Merrill.
20190-203	14	Santa Ysabel, California.....	H. W. Henshaw.
20380	1	Witch Creek, California.....	H. W. Henshaw.
21499	1	Valley de los Palmas, Lower California.....	A. W. Anthony.
22066-80	15	Tecate River, Lower California.....	Dr. E. A. Mearns.
22412	1	Vancouver Island, British Columbia.....	John Macoun.
23676-94	10	San Pedro Mountains, Lower California.....	C. H. Townsend.
23695	1	Fort Townsend, Washington.....	C. H. Townsend.

## EXPLANATION OF PLATE XXXIX.

- Fig. 1. Profile of head, diagrammatic.  
2. Coloration, style I.  
3. Coloration, style II.  
4. Coloration, style III.  
5. Coloration, style IV.  
6. Coloration, style V.  
7. Under surface of right hand, somewhat enlarged.  
8, 9, and 10. Under surface of right foot, somewhat enlarged.  
8. No. 20191, U.S.N.M., Santa Ysabel, California.  
9. No. 18809, U.S.N.M., Panamint Mountains, California.  
10. No. 14727, U.S.N.M., Fort Klamath, Oregon.